11985

FIG. 1

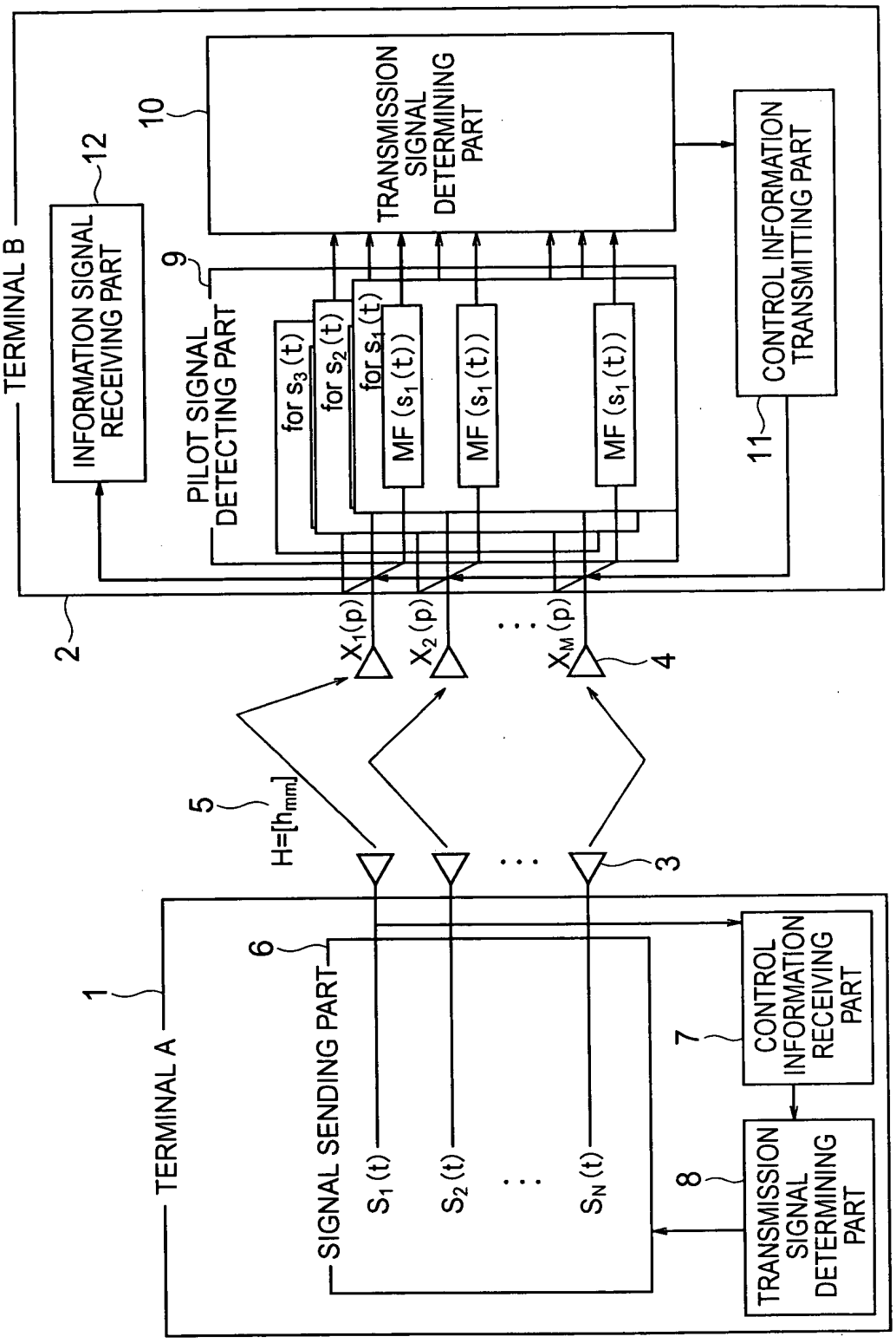

TERMINAL B
INFORMATION SIGNAL RECEIVING PART
12
10
TRANSMISSION SIGNAL DETERMINING PART
9
PILOT SIGNAL DETECTING PART
for s_3 (t)
for s_2 (t)
for s_1 (t)
MF (s_1 (t))
MF (s_1 (t))
MF (s_1 (t))
CONTROL INFORMATION TRANSMITTING PART
11
2
X_1(p)
X_2(p)
X_M(p)
4
5
H=[h_{mm}]
3
1
TERMINAL A
6
SIGNAL SENDING PART
S_1 (t)
S_2 (t)
S_N (t)
7
CONTROL INFORMATION RECEIVING PART
8
TRANSMISSION SIGNAL DETERMINING PART

FIG. 2

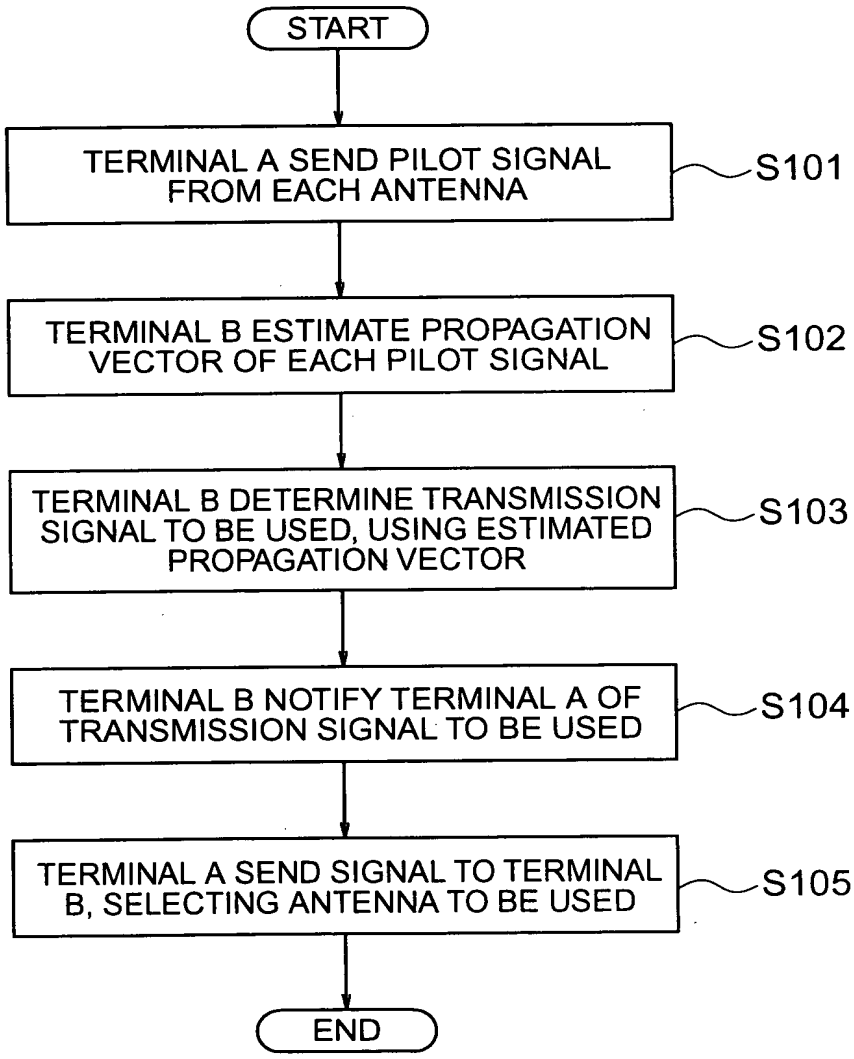

START
TERMINAL A SEND PILOT SIGNAL FROM EACH ANTENNA
S101
TERMINAL B ESTIMATE PROPAGATION VECTOR OF EACH PILOT SIGNAL
S102
TERMINAL B DETERMINE TRANSMISSION SIGNAL TO BE USED, USING ESTIMATED PROPAGATION VECTOR
S103
TERMINAL B NOTIFY TERMINAL A OF TRANSMISSION SIGNAL TO BE USED
S104
TERMINAL A SEND SIGNAL TO TERMINAL B, SELECTING ANTENNA TO BE USED
S105
END

FIG. 3

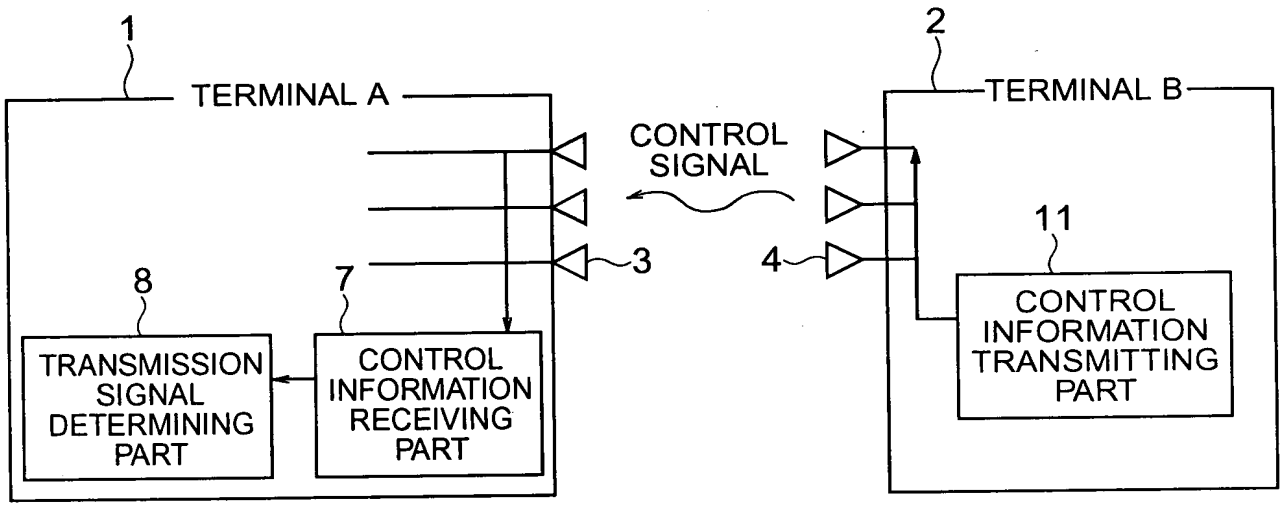

1
TERMINAL A
2
TERMINAL B
CONTROL SIGNAL
3
4
11
8
7
TRANSMISSION SIGNAL DETERMINING PART
CONTROL INFORMATION RECEIVING PART
CONTROL INFORMATION TRANSMITTING PART

FIG. 4

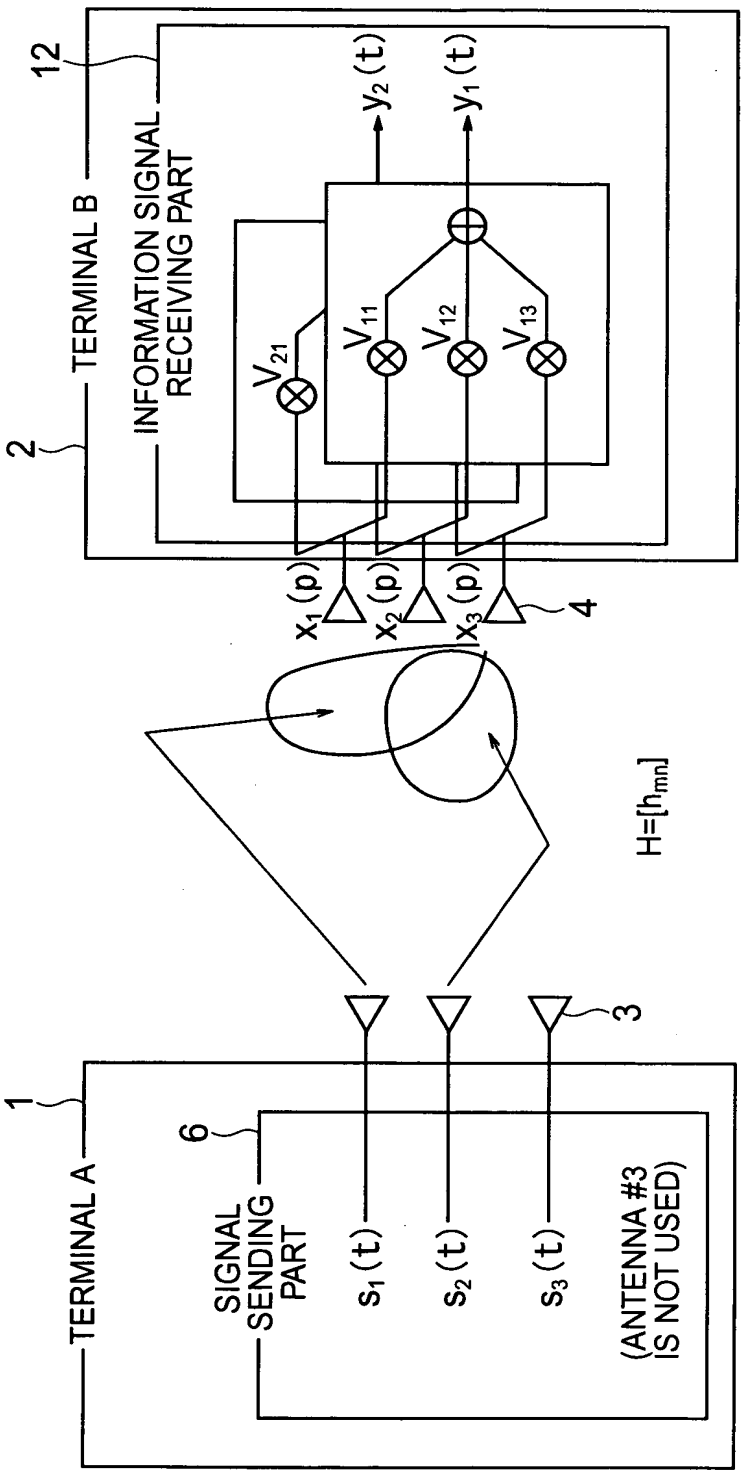

TERMINAL A
1
6
SIGNAL SENDING PART
$s_1(t)$
$s_2(t)$
$s_3(t)$
(ANTENNA #3 IS NOT USED)
3
H=[h_{mn}]
4
$x_1(p)$
$x_2(p)$
$x_3(p)$
2
TERMINAL B
12
INFORMATION SIGNAL RECEIVING PART
V_{21}
V_{11}
V_{12}
V_{13}
$y_2(t)$
$y_1(t)$

FIG. 5

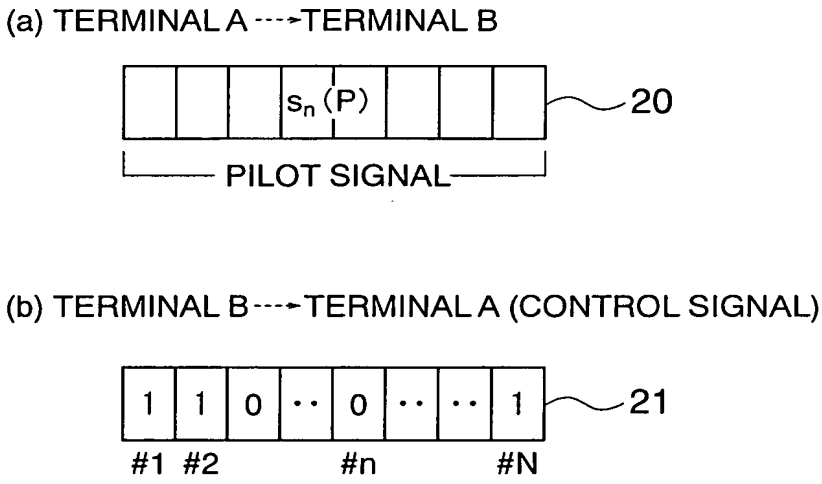

(a) TERMINAL A ---→TERMINAL B
s_n (P)
20
PILOT SIGNAL
(b) TERMINAL B ---→TERMINAL A (CONTROL SIGNAL)
1 1 0 •• 0 •• •• 1
21
#1 #2 #n #N

FIG. 6

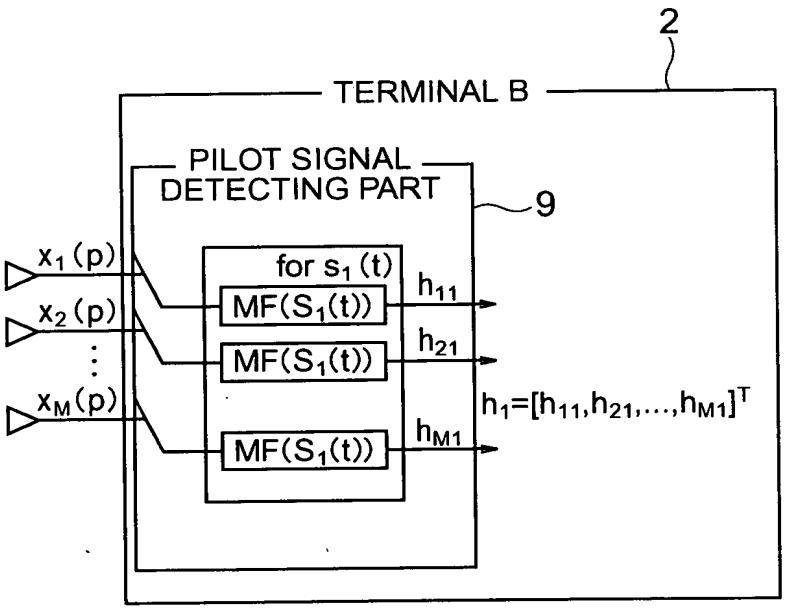

2
TERMINAL B
PILOT SIGNAL DETECTING PART
9
$x_1(p)$
$x_2(p)$
$x_M(p)$
for $s_1(t)$
$MF(S_1(t))$
$MF(S_1(t))$
$MF(S_1(t))$
h_{11}
h_{21}
h_{M1}
$h_1=[h_{11},h_{21},\ldots,h_{M1}]^T$

FIG. 7

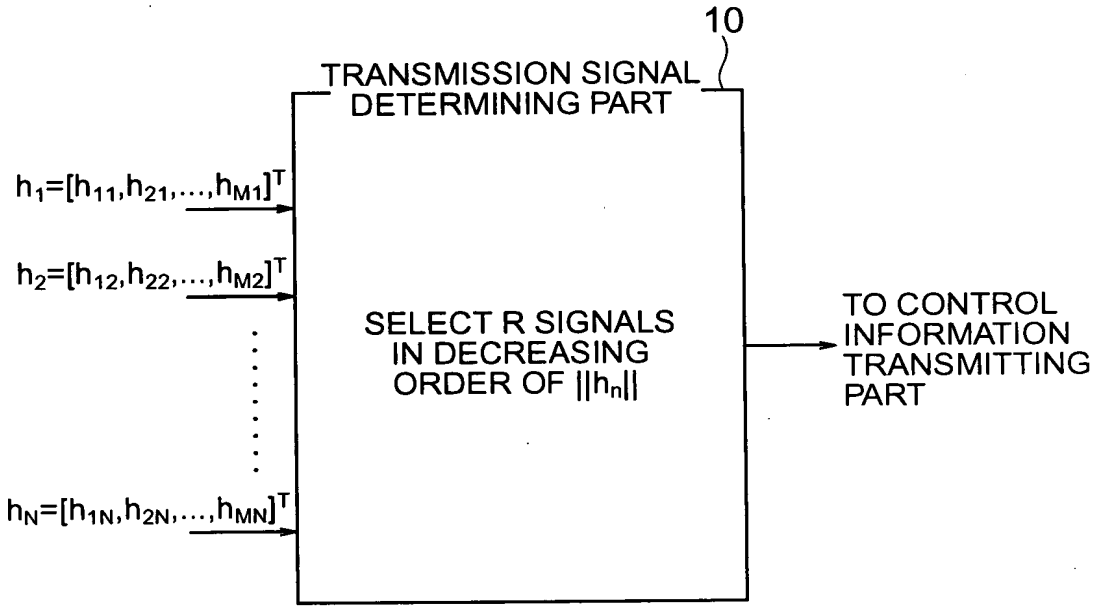

10
TRANSMISSION SIGNAL DETERMINING PART
$h_1=[h_{11},h_{21},\ldots,h_{M1}]^T$
$h_2=[h_{12},h_{22},\ldots,h_{M2}]^T$
$h_N=[h_{1N},h_{2N},\ldots,h_{MN}]^T$
SELECT R SIGNALS IN DECREASING ORDER OF $||h_n||$
TO CONTROL INFORMATION TRANSMITTING PART

FIG. 8

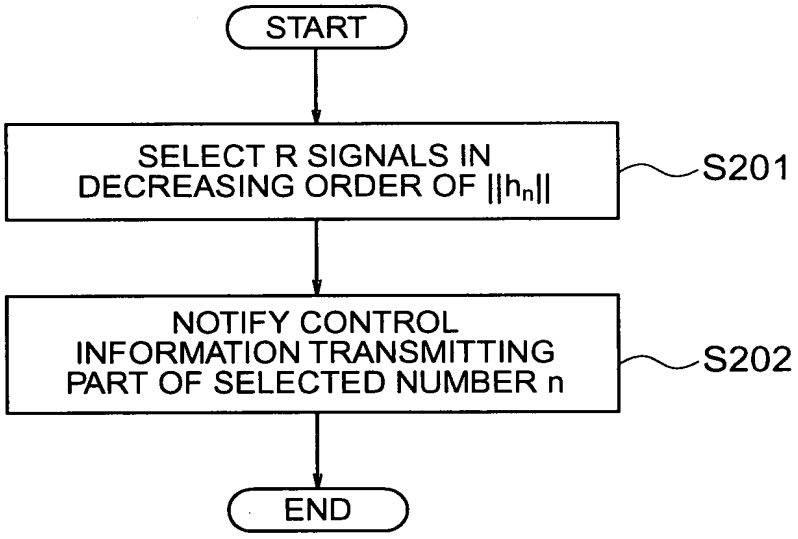

START
SELECT R SIGNALS IN DECREASING ORDER OF ||hn||
S201
NOTIFY CONTROL INFORMATION TRANSMITTING PART OF SELECTED NUMBER n
S202
END

FIG. 9

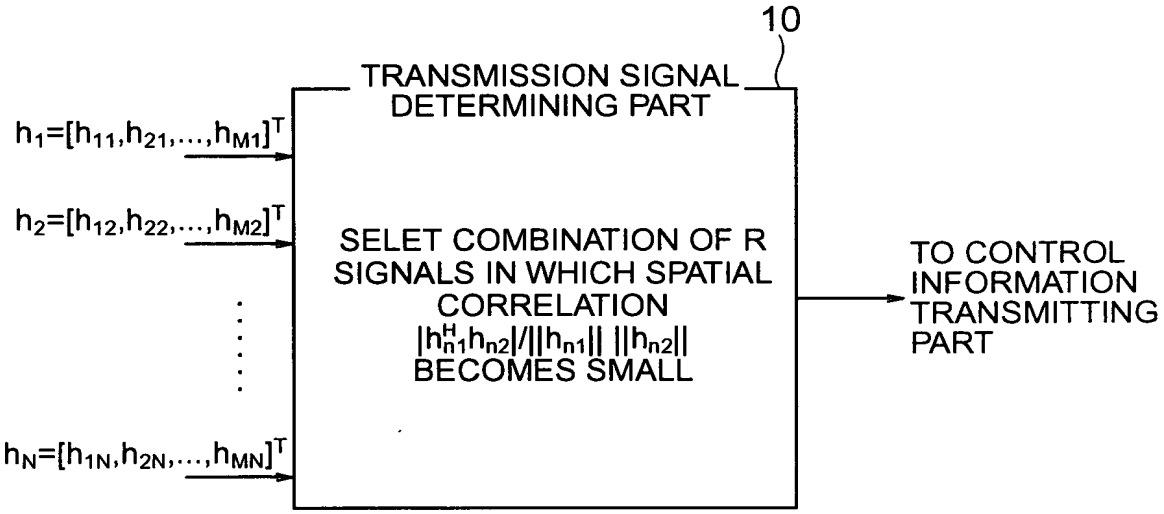

10
TRANSMISSION SIGNAL DETERMINING PART
$h_1=[h_{11},h_{21},\ldots,h_{M1}]^T$
$h_2=[h_{12},h_{22},\ldots,h_{M2}]^T$
$h_N=[h_{1N},h_{2N},\ldots,h_{MN}]^T$
SELET COMBINATION OF R SIGNALS IN WHICH SPATIAL CORRELATION $|h_{n1}^H h_{n2}|/\|h_{n1}\| \|h_{n2}\|$ BECOMES SMALL
TO CONTROL INFORMATION TRANSMITTING PART

FIG. 10

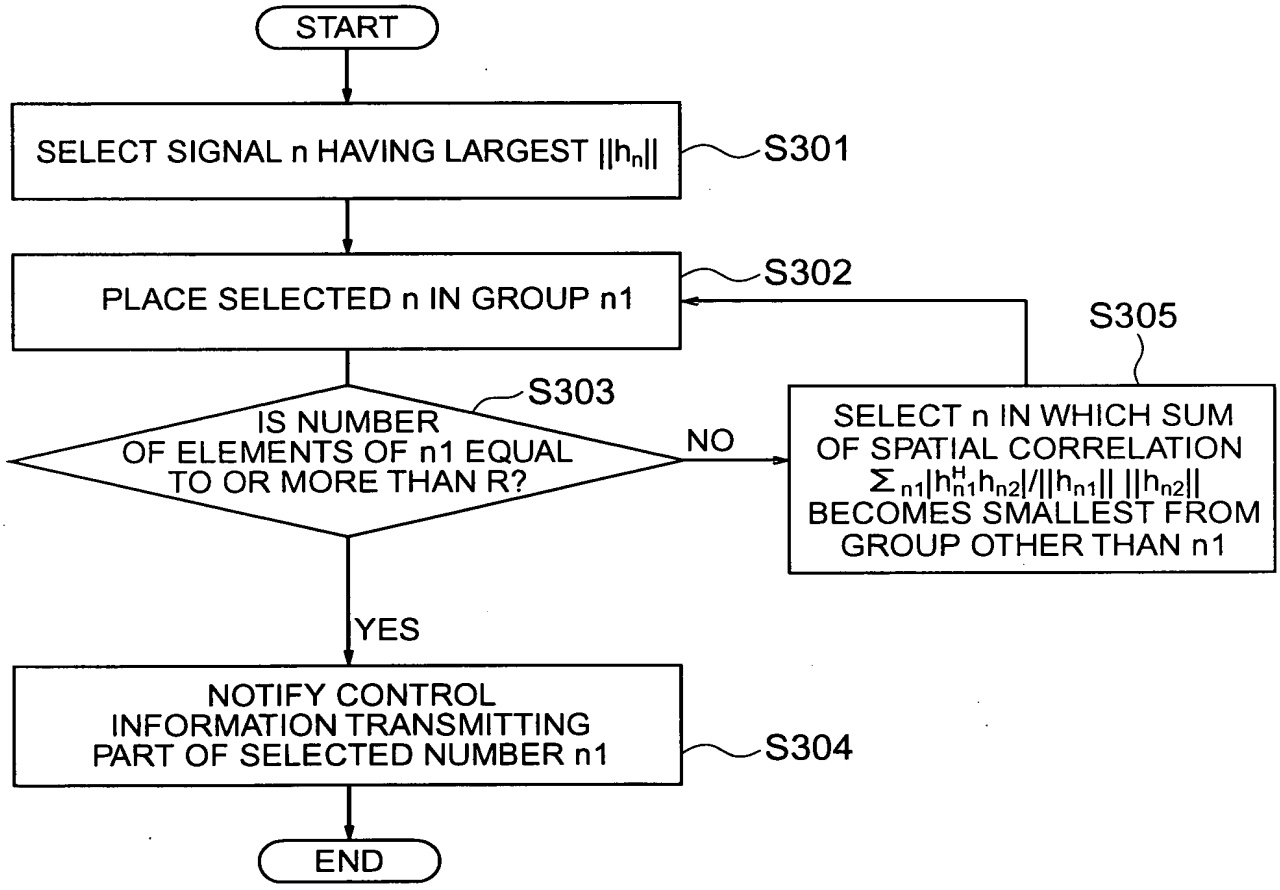

START
SELECT SIGNAL n HAVING LARGEST ||hn||
S301
PLACE SELECTED n IN GROUP n1
S302
S305
S303
IS NUMBER OF ELEMENTS OF n1 EQUAL TO OR MORE THAN R?
NO
SELECT n IN WHICH SUM OF SPATIAL CORRELATION Σn1|hn1Hhn2|/||hn1|| ||hn2|| BECOMES SMALLEST FROM GROUP OTHER THAN n1
YES
NOTIFY CONTROL INFORMATION TRANSMITTING PART OF SELECTED NUMBER n1
S304
END

FIG. 11

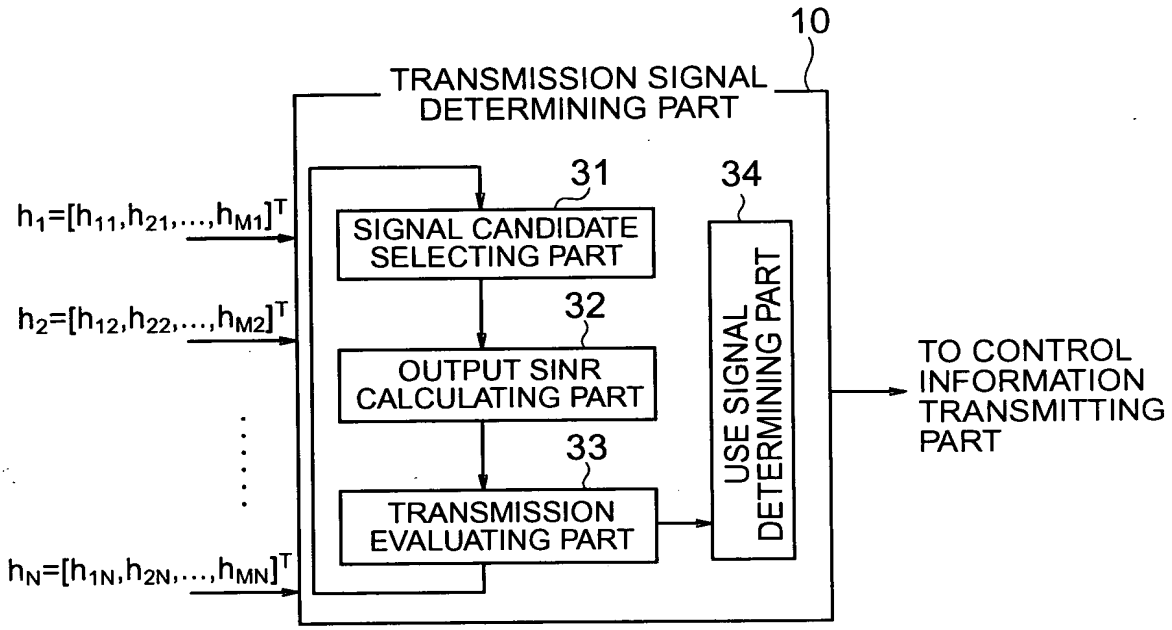

10
TRANSMISSION SIGNAL DETERMINING PART
31
34
SIGNAL CANDIDATE SELECTING PART
32
OUTPUT SINR CALCULATING PART
33
TRANSMISSION EVALUATING PART
USE SIGNAL DETERMINING PART
$h_1=[h_{11},h_{21},\ldots,h_{M1}]^T$
$h_2=[h_{12},h_{22},\ldots,h_{M2}]^T$
$h_N=[h_{1N},h_{2N},\ldots,h_{MN}]^T$
TO CONTROL INFORMATION TRANSMITTING PART

FIG. 12

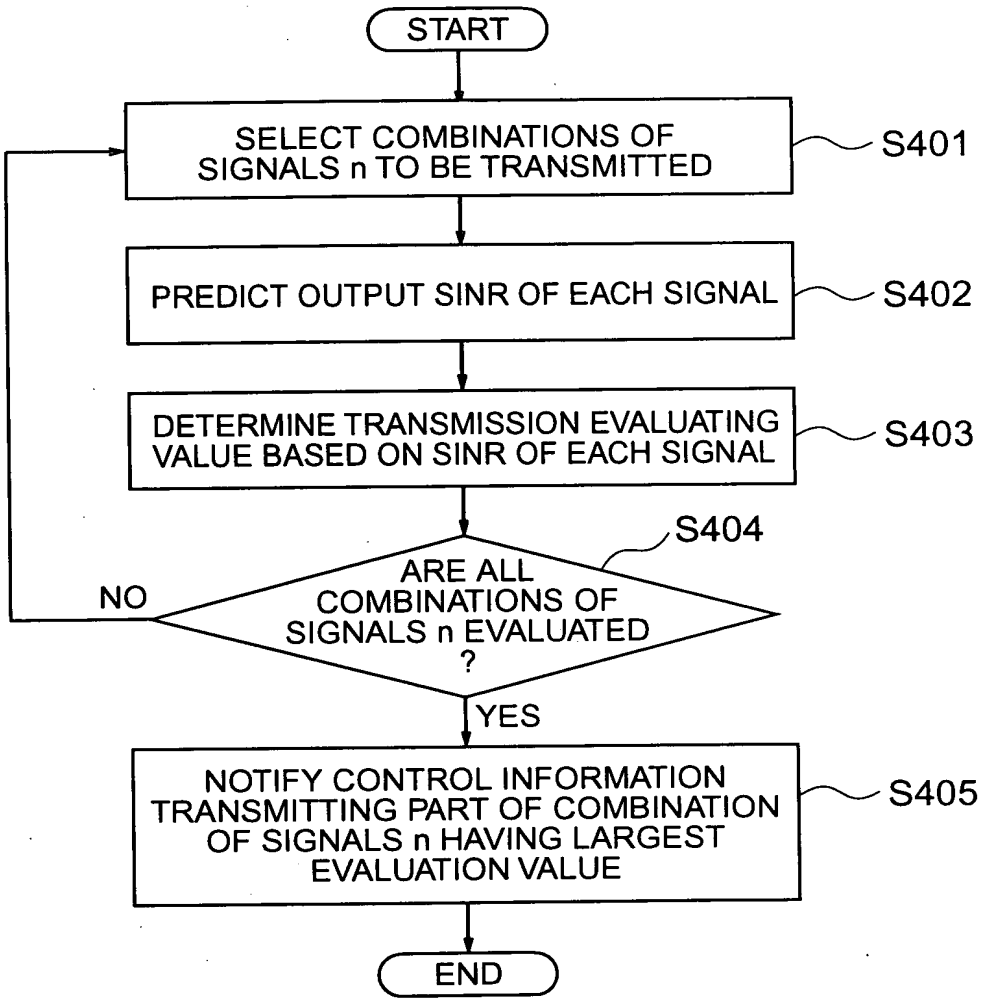

START
SELECT COMBINATIONS OF SIGNALS n TO BE TRANSMITTED
S401
PREDICT OUTPUT SINR OF EACH SIGNAL
S402
DETERMINE TRANSMISSION EVALUATING VALUE BASED ON SINR OF EACH SIGNAL
S403
S404
ARE ALL COMBINATIONS OF SIGNALS n EVALUATED ?
NO
YES
NOTIFY CONTROL INFORMATION TRANSMITTING PART OF COMBINATION OF SIGNALS n HAVING LARGEST EVALUATION VALUE
S405
END

FIG. 13

◆SINR PREDICTION

$$\Gamma_n = \frac{|h_n^H v_n(p)|^2}{v_n^H(\sum_{n0} h_{n0} h_{n0}^H + P_N|)V_n - |h_n^H v_n(p)|^2} \quad (41)$$

v_n : RECEPTION WEIGHT $v_n = (\sum_{n0} h_{n0} h_{n0}^H)^{-1} h_{n0}$ IN CASE OF ZF STANDARD TYPE

$v_n = (\sum_{n0} h_{n0} h_{n0}^H + P_N I)^{-1} h_{n0}$ IN CASE OF MMSE STANDARD TYPE

$\hat{P}_N$: INTERFERENCE NOISE POWER ESTIMATED VALUE

FIG. 14

SINR[dB]	EVALUATION VALUE (ACCEPTANCE OR REJECTION OF USE)
-3	0
-2	0
⋮	⋮
3	0
4	1
⋮	⋮
28	1

FIG. 15

51 COMBINATION OF SIGNALS (#1,#2,#3) 1; USE, 0; NON-USE	52 OUTPUT SINR [dB] ($\Gamma_1, \Gamma_2, \Gamma_3$)	53 EVALUATION VALUE OF EACH SIGNAL (#1,#2,#3)	54 TOTAL OF EVALUATION VALUES
(1, 0, 0)	(7.0, 0.0, 0.0)	(1, 0, 0)	1
(0, 1, 0)	(0.0, 9.3, 0.0)	(0, 1, 0)	1
(0, 0, 1)	(0.0, 0.0, 6.2)	(0, 0, 1)	1
(1, 1, 0)	(6.0, 7.0, 0.0)	(1, 1, 0)	2
(0, 1, 1)	(0.0, 4.3, 2.9)	(0, 1, 0)	1
(1, 0, 1)	(2.8, 0.0, 1.1)	(0, 0, 0)	0
(1, 1, 1)	(−0.5, 3.4, 0.3)	(0, 0, 0)	0

55

※ IN CASE OF THREE TRANSMISSION ANTENNAS

SELECT LARGEST EVALUATION VALUE

FIG. 16

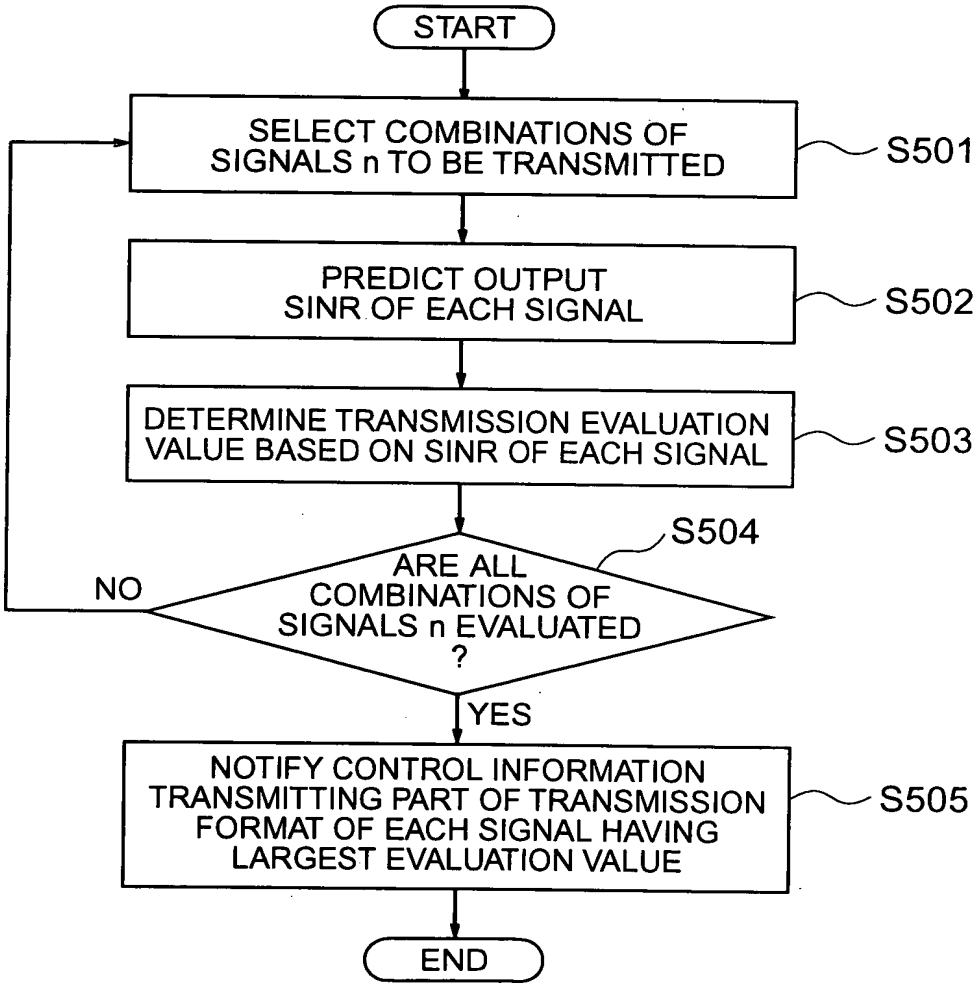

START
SELECT COMBINATIONS OF SIGNALS n TO BE TRANSMITTED
S501
PREDICT OUTPUT SINR OF EACH SIGNAL
S502
DETERMINE TRANSMISSION EVALUATION VALUE BASED ON SINR OF EACH SIGNAL
S503
S504
ARE ALL COMBINATIONS OF SIGNALS n EVALUATED ?
NO
YES
NOTIFY CONTROL INFORMATION TRANSMITTING PART OF TRANSMISSION FORMAT OF EACH SIGNAL HAVING LARGEST EVALUATION VALUE
S505
END

FIG. 17

61 TRANSMISSION SPECIFICATION NUMBER	62 SINR [dB]	63 MODULATION SCHEME	64 CODING RATIO	65 EVALUATION VALUE (TRANSMISSION SPEED)
0	～-3	No use	No use	0.000
1	-3～-2	QPSK	1／8	0.500
2	-2～-1	QPSK	1／7	0.571
3	-1～0	QPSK	1／6	0.666
4	0～1	QPSK	1／5	0.800
5	1～2	QPSK	1／4	1.000
6	2～3	QPSK	1／3	1.333
⋮	⋮	⋮	⋮	⋮
31	27～	16QAM	3/4	12.000

FIG. 18

71 COMBINATION OF SIGNALS (#1,#2,#3) 1; USE, 0; NON-USE	72 OUTPUT SINR [dB] ($\Gamma_1, \Gamma_2, \Gamma_3$)	73 EVALUATION VALUE OF EACH SIGNAL (TRANSMISSION SPEED)(#1,#2,#3)	74 TOTAL OF EVALUATION VALUES
(1,0,0)	(7.0,-,-)	(6.0,0.0,0.0)	6.0
(0,1,0)	(-,9.3,-)	(0.0,7.2,0.0)	7.2
(0,0,1)	(-,-,6.2)	(0.0,0.0,4.8)	4.8
(1,1,0)	(6.0,7.0,-)	(4.5,6.0,0.0)	10.5
(0,1,1)	(-,4.3,2.9)	(0.0,2.2,1.3)	3.8
(1,0,1)	(2.8,-,1.1)	(1.3,0.0,1.0)	2.3
(1,1,1)	(-0.5,3.4,0.3)	(0.6,1.5,1.8)	2.9

※ IN CASE OF THREE TRANSMISSION ANTENNAS

SELECT LARGEST EVALUATION VALUE

FIG. 19

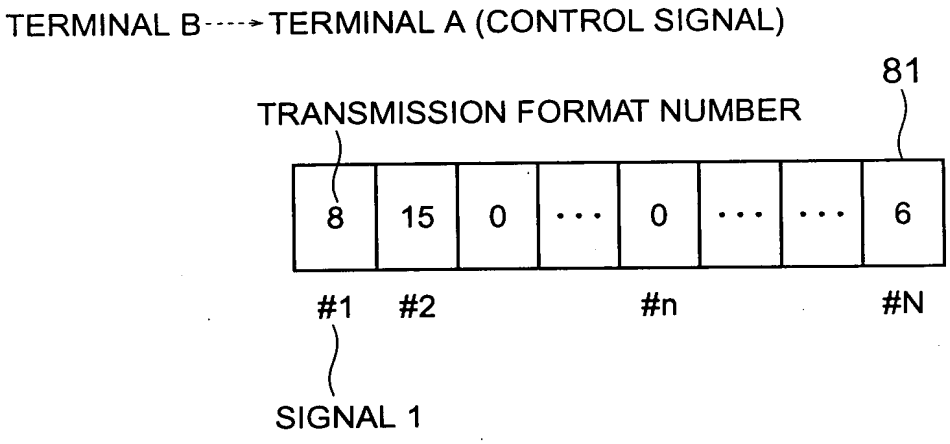

TERMINAL B----→TERMINAL A (CONTROL SIGNAL)
81
TRANSMISSION FORMAT NUMBER
8
15
0
• • •
0
• • •
• • •
6
#1
#2
#n
#N
SIGNAL 1

FIG. 20

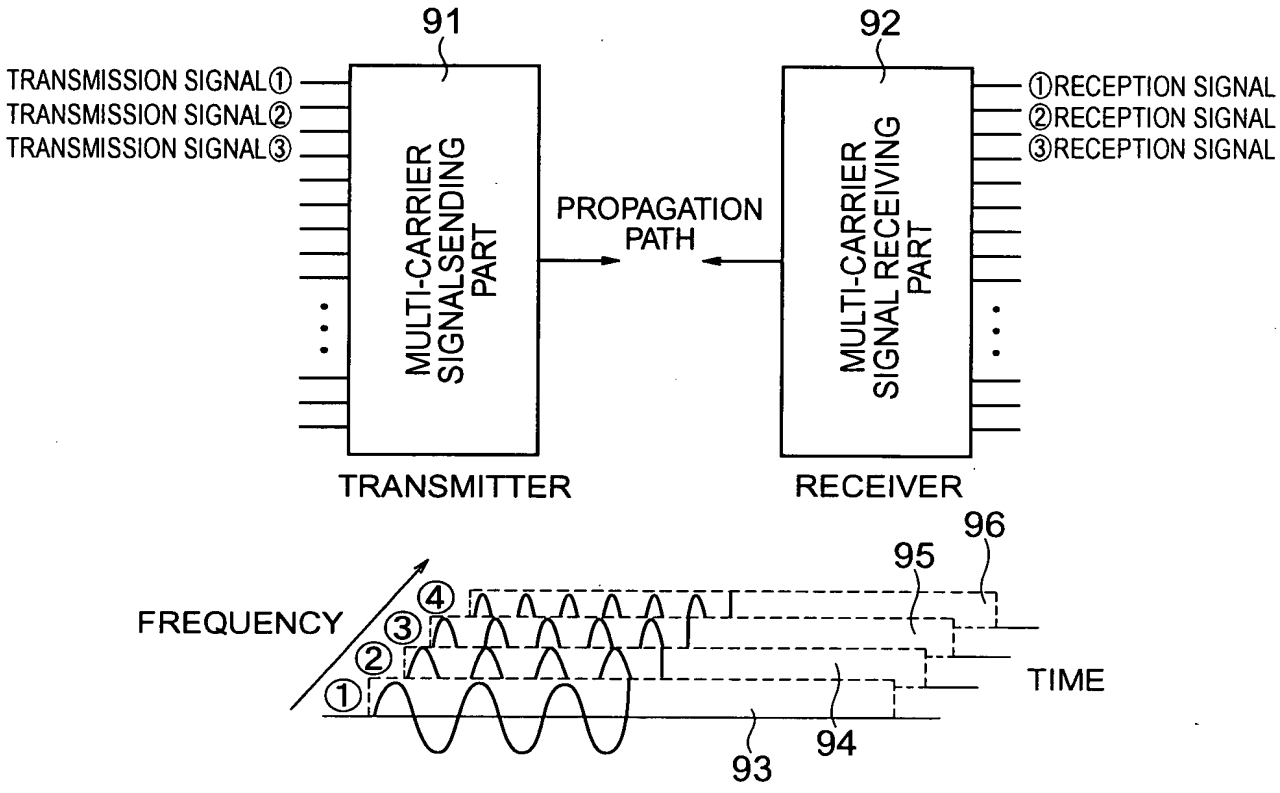

91
92
TRANSMISSION SIGNAL①
TRANSMISSION SIGNAL②
TRANSMISSION SIGNAL③
MULTI-CARRIER SIGNALSENDING PART
PROPAGATION PATH
MULTI-CARRIER SIGNAL RECEIVING PART
①RECEPTION SIGNAL
②RECEPTION SIGNAL
③RECEPTION SIGNAL
TRANSMITTER
RECEIVER
96
95
FREQUENCY
④
③
②
①
TIME
94
93

FIG. 21

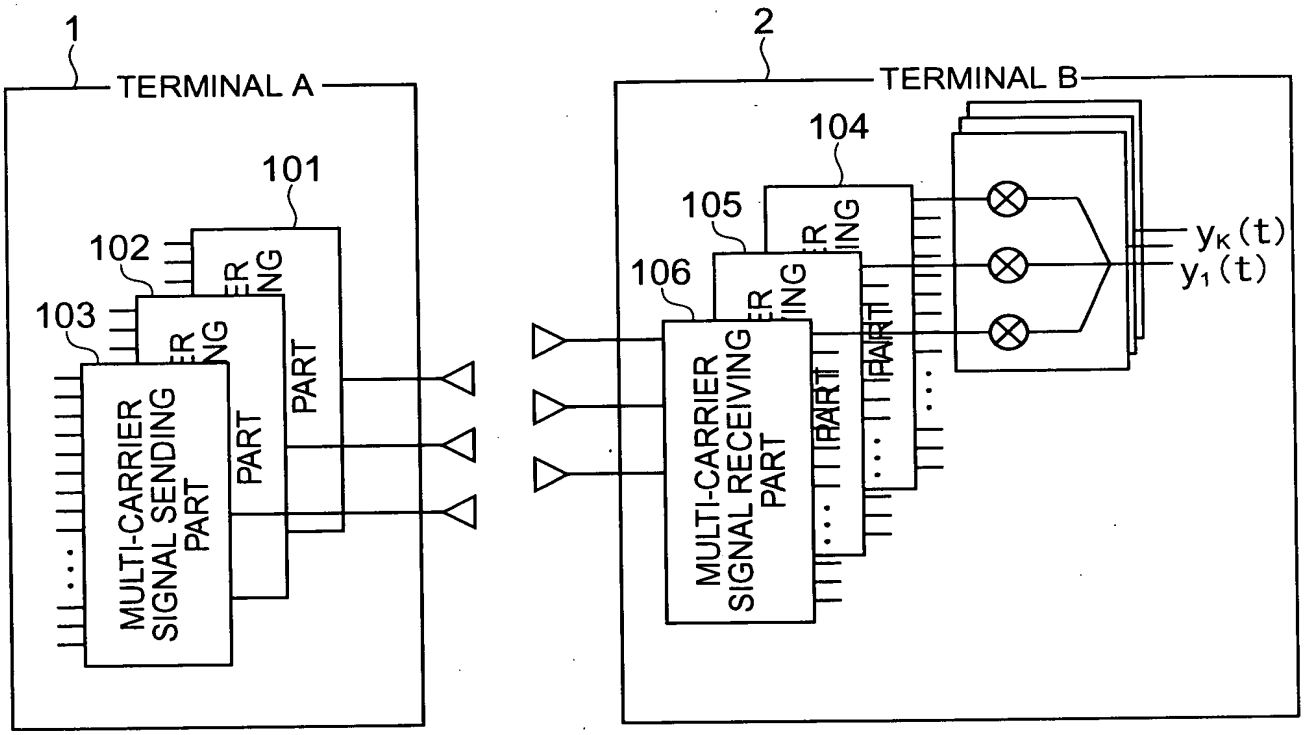

1
TERMINAL A
101
102
103
MULTI-CARRIER SIGNAL SENDING PART
PART
PART
2
TERMINAL B
104
105
106
MULTI-CARRIER SIGNAL RECEIVING PART
$y_K(t)$
$y_1(t)$

FIG. 22

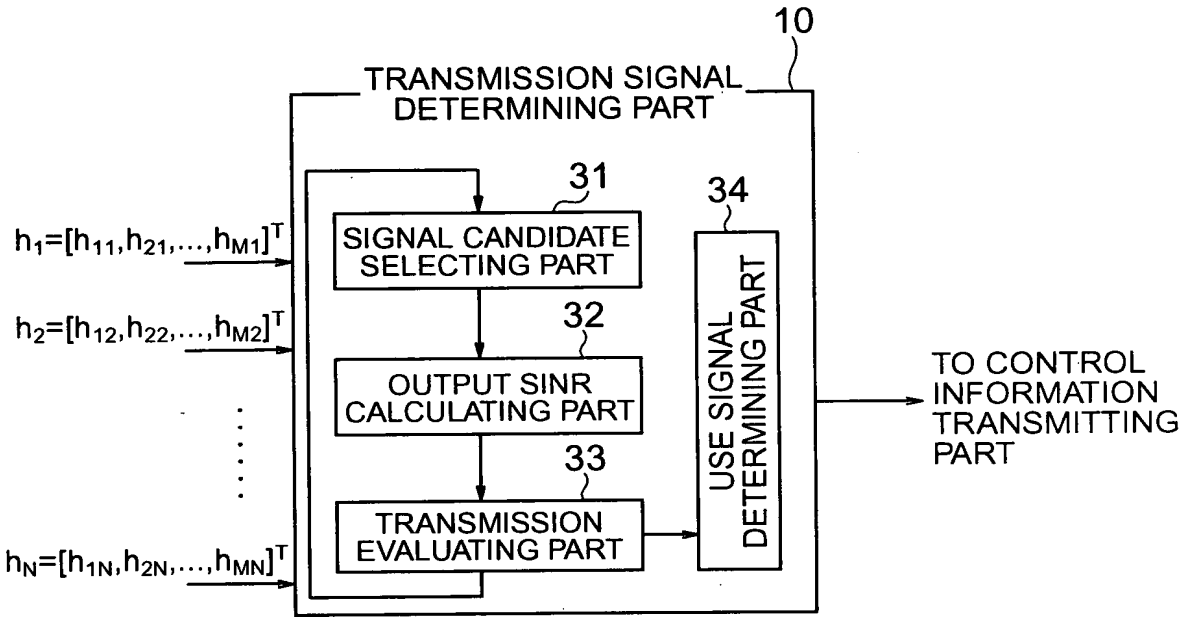

10
TRANSMISSION SIGNAL DETERMINING PART
31
SIGNAL CANDIDATE SELECTING PART
32
OUTPUT SINR CALCULATING PART
33
TRANSMISSION EVALUATING PART
34
USE SIGNAL DETERMINING PART
$h_1=[h_{11},h_{21},\ldots,h_{M1}]^T$
$h_2=[h_{12},h_{22},\ldots,h_{M2}]^T$
$h_N=[h_{1N},h_{2N},\ldots,h_{MN}]^T$
TO CONTROL INFORMATION TRANSMITTING PART

FIG. 23

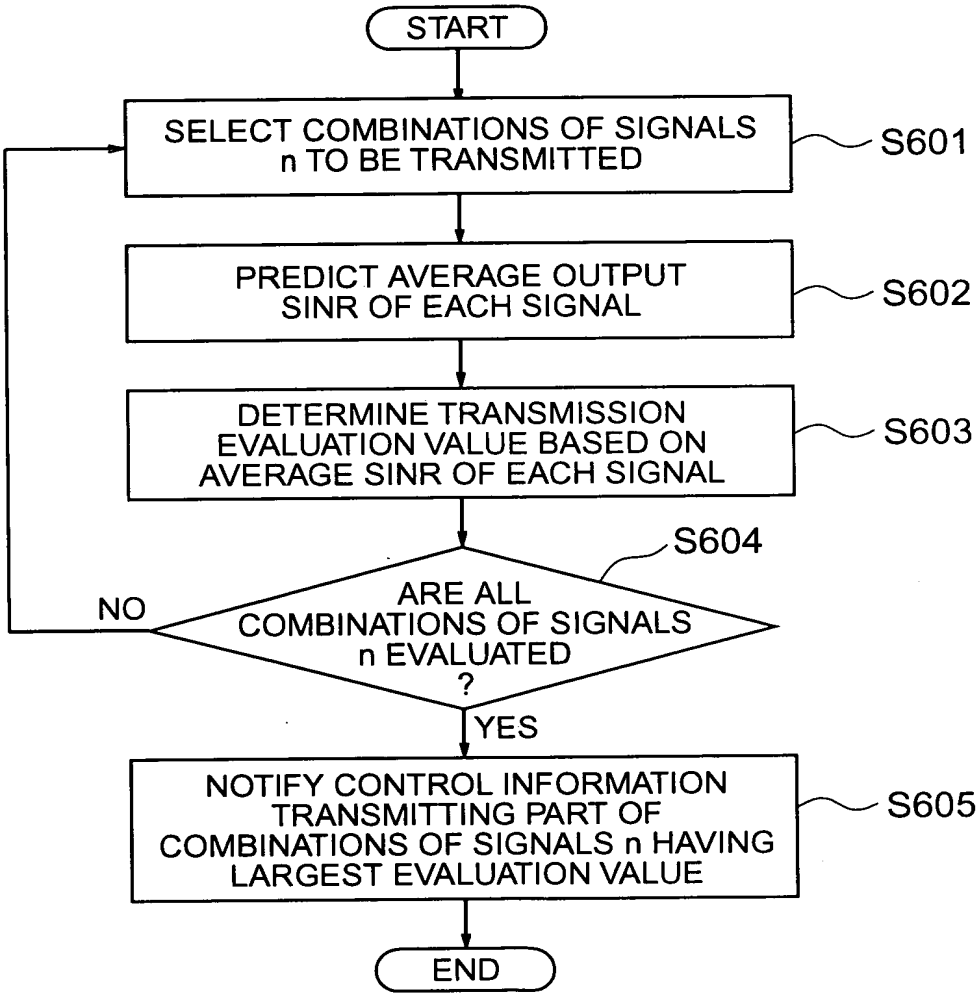

START
SELECT COMBINATIONS OF SIGNALS n TO BE TRANSMITTED
S601
PREDICT AVERAGE OUTPUT SINR OF EACH SIGNAL
S602
DETERMINE TRANSMISSION EVALUATION VALUE BASED ON AVERAGE SINR OF EACH SIGNAL
S603
S604
ARE ALL COMBINATIONS OF SIGNALS n EVALUATED ?
NO
YES
NOTIFY CONTROL INFORMATION TRANSMITTING PART OF COMBINATIONS OF SIGNALS n HAVING LARGEST EVALUATION VALUE
S605
END

FIG. 24

AVERAGE SINR $\Gamma_n = E_1[\Gamma_{n,1}]$

$\Gamma_{n,1}$: SINR (SUB-CARRIER UNIT)

※n: TRANSMISSION ANTENNA、1 : SUB-CARRIER NUMBER

FIG. 25

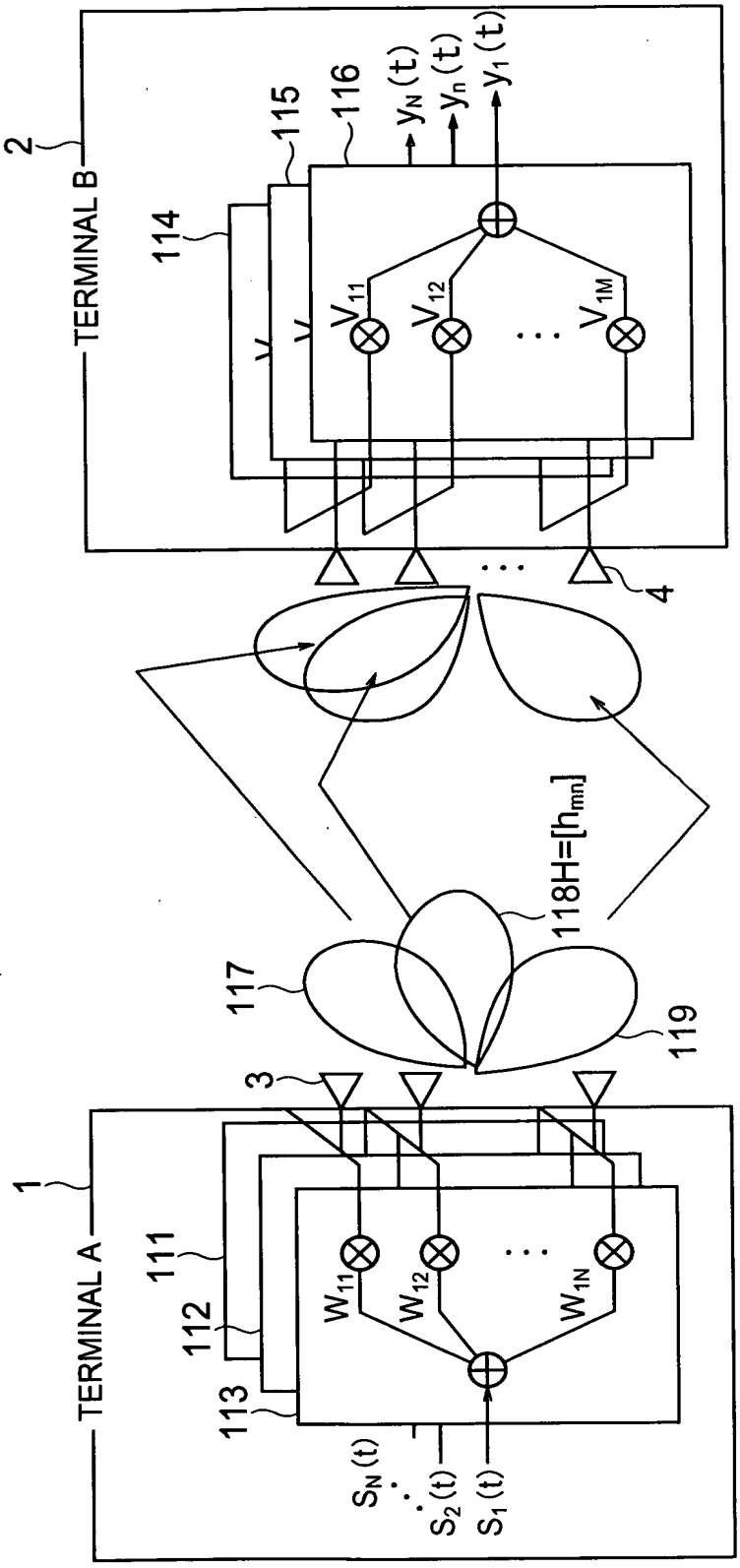

TERMINAL A
TERMINAL B
1
2
3
4
111
112
113
114
115
116
117
118H=[h_mn]
119
W11
W12
W1N
V11
V12
V1M
S1(t)
S2(t)
SN(t)
y1(t)
yn(t)
yN(t)

FIG. 26

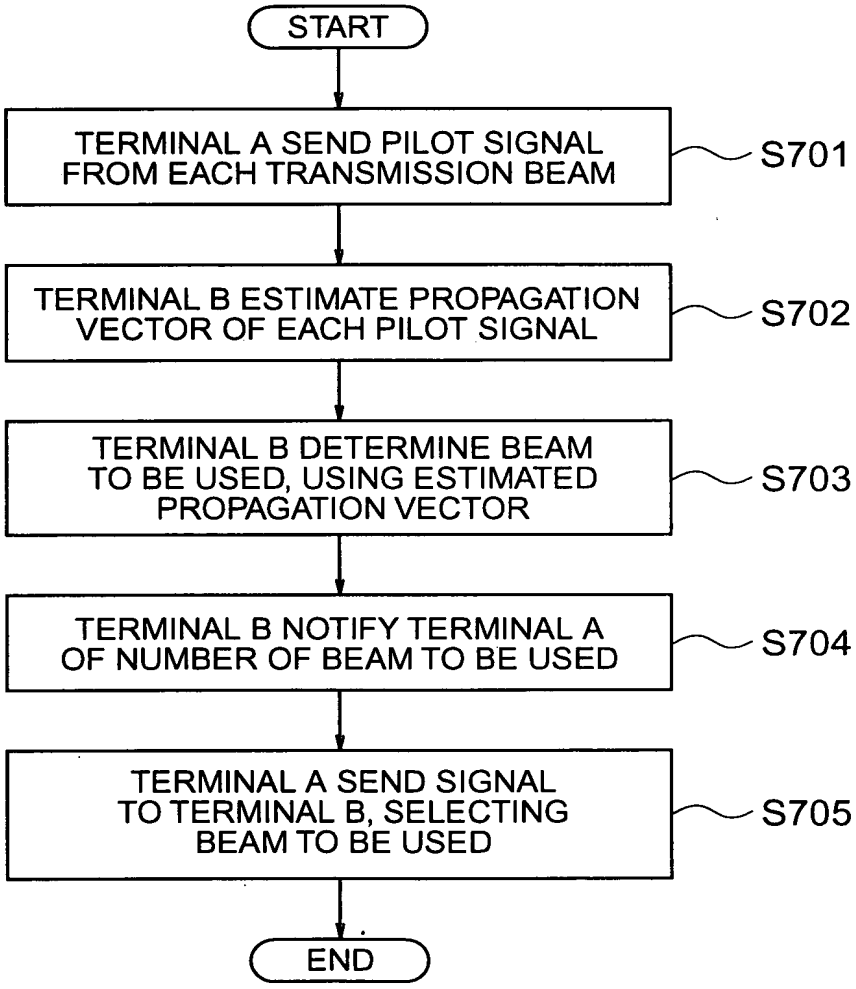

START
TERMINAL A SEND PILOT SIGNAL FROM EACH TRANSMISSION BEAM
S701
TERMINAL B ESTIMATE PROPAGATION VECTOR OF EACH PILOT SIGNAL
S702
TERMINAL B DETERMINE BEAM TO BE USED, USING ESTIMATED PROPAGATION VECTOR
S703
TERMINAL B NOTIFY TERMINAL A OF NUMBER OF BEAM TO BE USED
S704
TERMINAL A SEND SIGNAL TO TERMINAL B, SELECTING BEAM TO BE USED
S705
END

FIG. 27

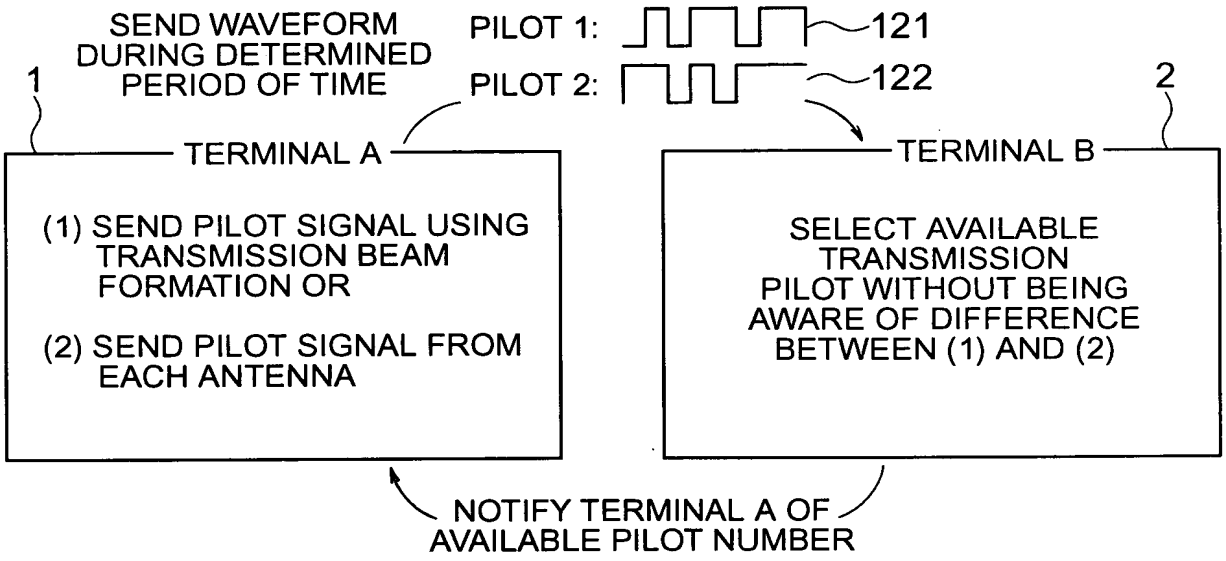

SEND WAVEFORM DURING DETERMINED PERIOD OF TIME
PILOT 1:
121
PILOT 2:
122
1
2
TERMINAL A
TERMINAL B
(1) SEND PILOT SIGNAL USING TRANSMISSION BEAM FORMATION OR
(2) SEND PILOT SIGNAL FROM EACH ANTENNA
SELECT AVAILABLE TRANSMISSION PILOT WITHOUT BEING AWARE OF DIFFERENCE BETWEEN (1) AND (2)
NOTIFY TERMINAL A OF AVAILABLE PILOT NUMBER

FIG. 28

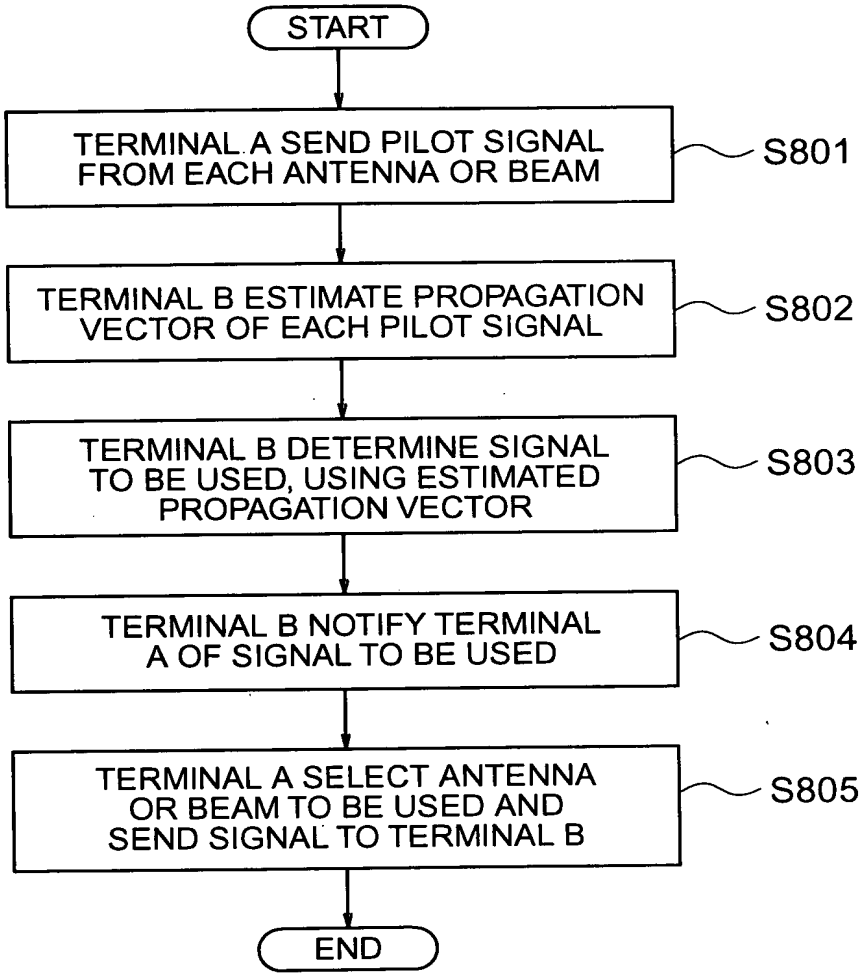

START
TERMINAL A SEND PILOT SIGNAL FROM EACH ANTENNA OR BEAM
S801
TERMINAL B ESTIMATE PROPAGATION VECTOR OF EACH PILOT SIGNAL
S802
TERMINAL B DETERMINE SIGNAL TO BE USED, USING ESTIMATED PROPAGATION VECTOR
S803
TERMINAL B NOTIFY TERMINAL A OF SIGNAL TO BE USED
S804
TERMINAL A SELECT ANTENNA OR BEAM TO BE USED AND SEND SIGNAL TO TERMINAL B
S805
END

FIG. 29

75 MAGNITUDE OF POWER OF EACH SIGNAL (#1,#2,#3)	72 OUTPUT SINR [dB] ($\Gamma_1, \Gamma_2, \Gamma_3$)	73 TRANSMISSION EVALUATION VALUE OF EACH SIGNAL (TRANSMISSION SPEED)(#1,#2,#3)	74 TOTAL OF TRANSMISSION EVALUATION VALUES
(3,0,0)	(14.0, - , -)	(9.5,0.0,0.0)	9.5
(0,3,0)	(- ,15.3, -)	(0.0,11.2,0.0)	11.2
(0,0,3)	(- , - ,2.2)	(0.0,0.0,8.8)	8.8
(2,1,0)	(9.1,6.8, -)	(5.4,4.5,0.0)	9.9
(0,2,1)	(- ,7.3,2.9)	(0.0,6.2,1.3)	7.5
⋮	⋮	⋮	⋮
(1,1,1)	(-0.5,3.4,0.3)	(0.6,1.5,1.8)	2.9

※ IN CASE OF THREE TRANSMISSION ANTENNAS

SELECT LARGEST TRANSMISSION SPEED

FIG. 30

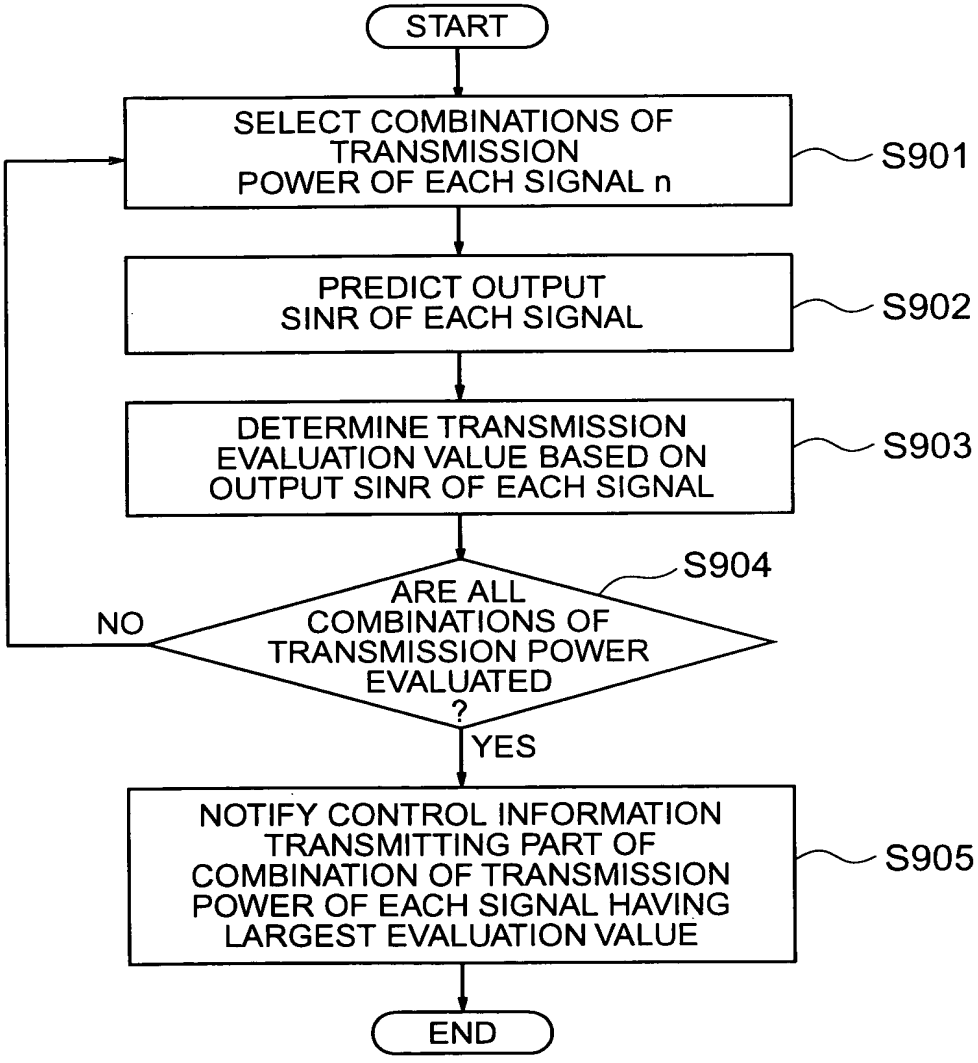

START
SELECT COMBINATIONS OF TRANSMISSION POWER OF EACH SIGNAL n
S901
PREDICT OUTPUT SINR OF EACH SIGNAL
S902
DETERMINE TRANSMISSION EVALUATION VALUE BASED ON OUTPUT SINR OF EACH SIGNAL
S903
S904
ARE ALL COMBINATIONS OF TRANSMISSION POWER EVALUATED ?
NO
YES
NOTIFY CONTROL INFORMATION TRANSMITTING PART OF COMBINATION OF TRANSMISSION POWER OF EACH SIGNAL HAVING LARGEST EVALUATION VALUE
S905
END

FIG. 31

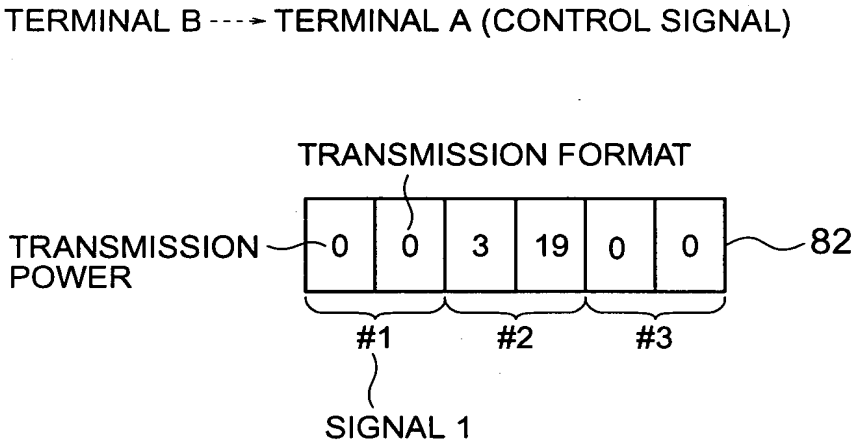

TERMINAL B ---> TERMINAL A (CONTROL SIGNAL)
TRANSMISSION FORMAT
TRANSMISSION POWER
0
0
3
19
0
0
82
#1
#2
#3
SIGNAL 1

FIG. 32

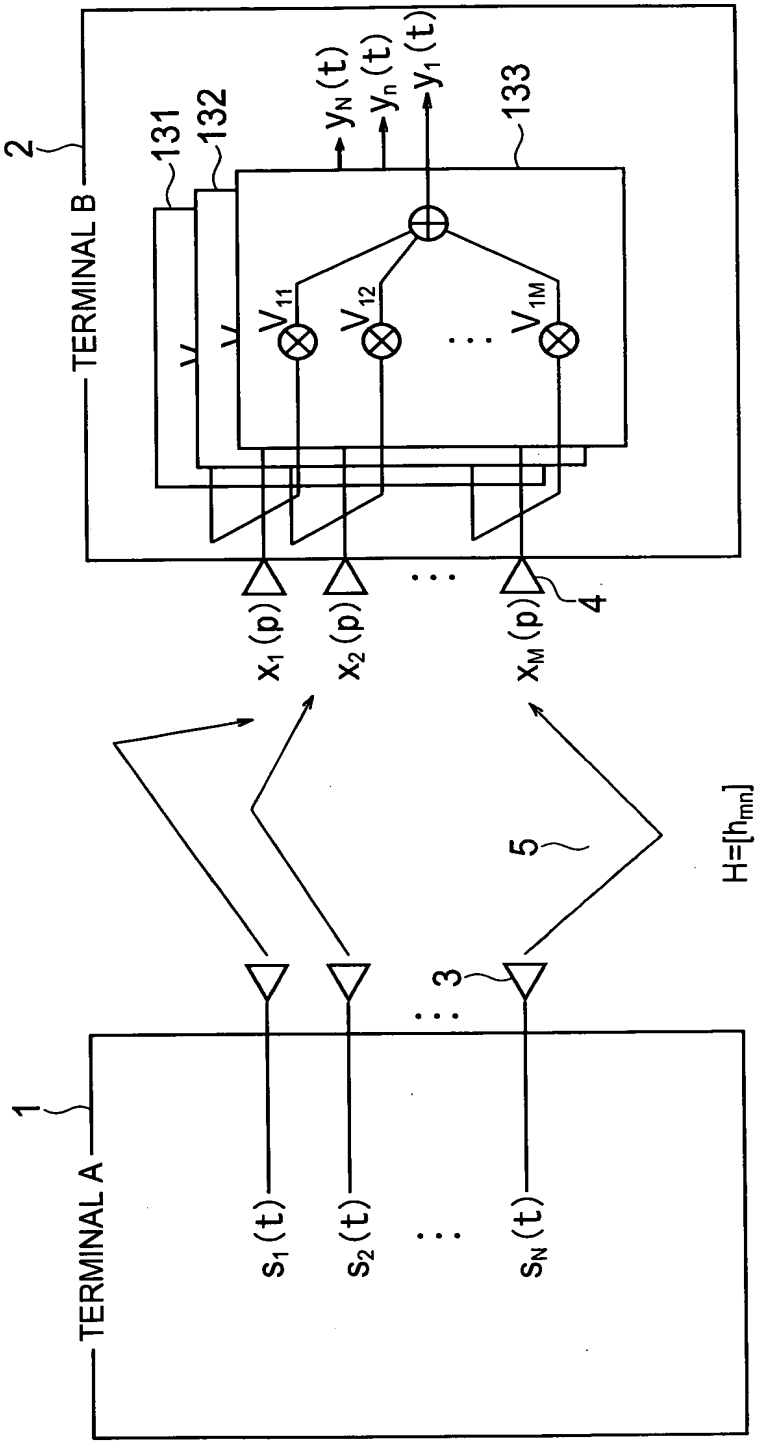
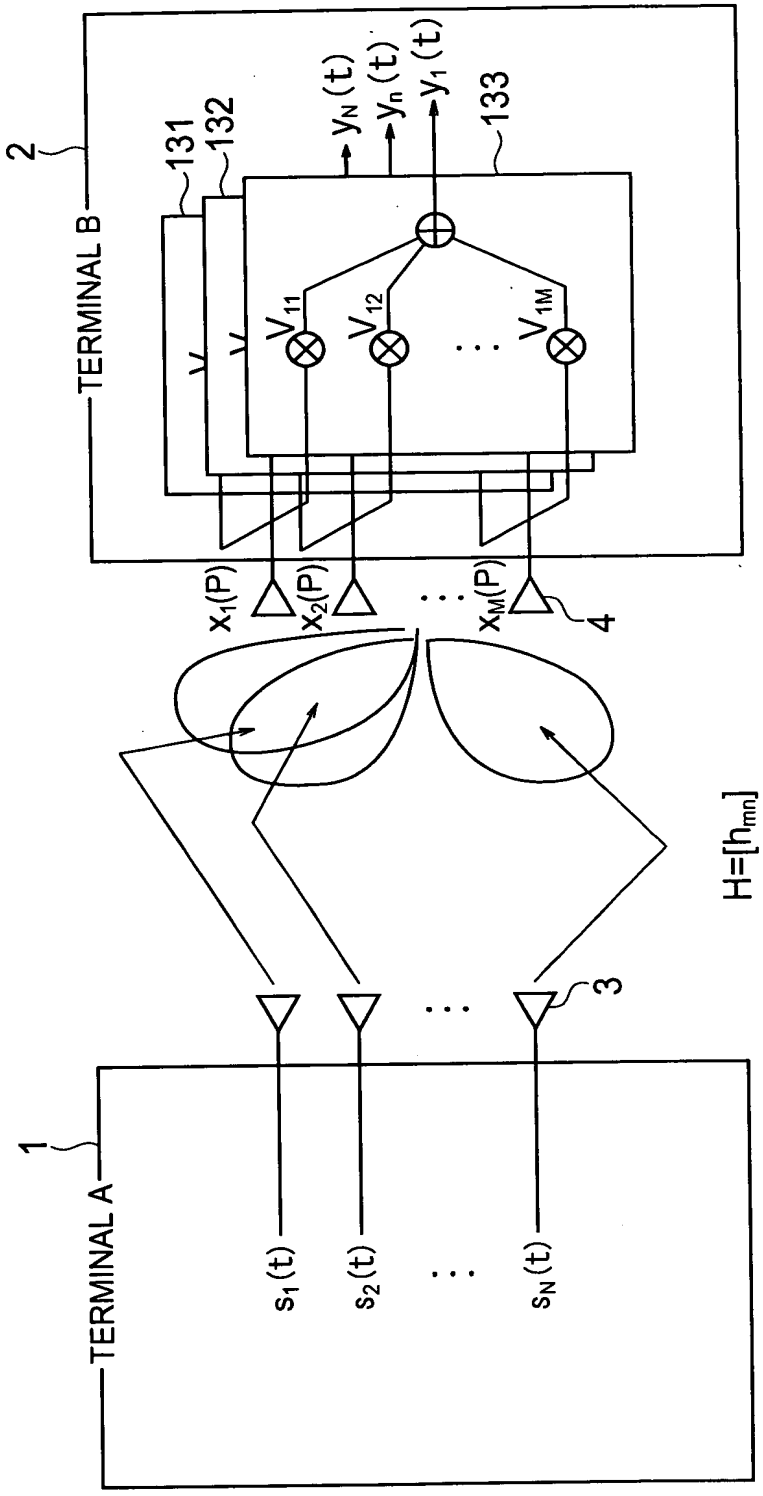

TERMINAL A
TERMINAL B
1
2
3
4
5
131
132
133
$s_1(t)$
$s_2(t)$
$s_N(t)$
$x_1(p)$
$x_2(p)$
$x_M(p)$
$y_1(t)$
$y_n(t)$
$y_N(t)$
V_{11}
V_{12}
V_{1M}
V
V
H=[h_{mn}]

FIG. 33


TERMINAL A
TERMINAL B
1
2
3
4
131
132
133
$s_1(t)$
$s_2(t)$
$s_N(t)$
$x_1(P)$
$x_2(P)$
$x_M(P)$
$y_1(t)$
$y_n(t)$
$y_N(t)$
V_{11}
V_{12}
V_{1M}
$H=[h_{mn}]$